The ABCs of communications towers

Determine initial and future uses for your new tower. Select a tower manufacturer and a tower installer with good reputations to protect the investment you make in the equipment. Inspect and maintain your tower regularly.

By Betty J. Pilar

Basic information about tower purchasing and installation will help you to communicate your requirements to a tower manufacturer, leading to better decisions and a smoother process from inception to installation.

General information

There are two basic types of towers, *guyed* and *self-supporting*. A guyed tower is a slender, steel structure supported by one or more levels of braided or stranded high-strength steel guy cables that anchor it to the ground. A self-supporting tower can be a three- or four-sided steel-lattice pyramid or box, or a tubular monopole.

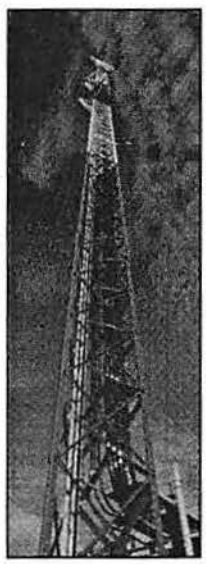
One important consideration in selecting a tower is how much land (and of what type) it will occupy. A guyed tower needs much more land than a self-supporting tower because the guy cables usually are anchored to the ground at a distance from the base equal to about 80% of the tower's height. For example, a 250-foot guyed tower may require more than four acres, whereas a 250-foot self-supporting tower requires less than one acre. Soil types on the prospective property have to be suitable for supporting foundations or for holding guy anchors.

Cost considerations

Comparing the cost of towers requires an examination of an entire list of expenses, including materials, erection time, shipping and land requirements. The material expense for guyed towers typically is less than for self-supporting towers because less steel is used. Most foundations for guyed towers cost less than those for self-supporting towers because they usually are smaller, requiring less concrete. Because less steel is used, on-site construction time for guyed towers is generally less than for self-supporting towers. Guyed towers with 20-foot-long, solid-steel, prewelded sections can be erected even quicker than formed-plate guyed towers, further reducing erection costs, but they may be more expensive to ship because of their weight and volume. Although these comparisons may make one think that a guyed tower costs less than a self-supporting tower, that may not be the case—because of land requirements.

The cost of land may be a prime consideration. If the site is in a remote area where land is readily available and its cost is relatively inexpensive, the guyed tower would be more economical. If the site must be located in a developed area with premium land costs, a self-supporting tower may be more economical despite its higher material, installation and transportation costs.

Pilar is a sales representative at Andrew Corporation, Orland Park, IL.



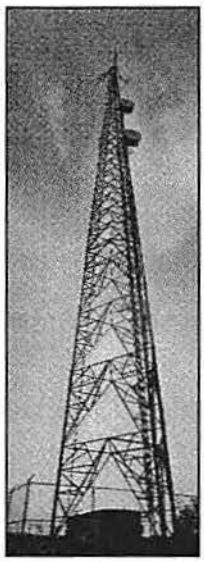


Photo 1 (left). All-bolted-construction, heavy-duty, guyed towers, such as this one with a 54-inch face width, can stand more than 550 feet high.

Photo 2 (right). This self-supporting pyramidal tower can handle heavy loads, and its steep taper allows it to fit where space is limited.

Maintenance

In general, annual inspection is recommended for all types of towers and should include checking the tower and antenna bolts, safety ladder, cable bridge, pressurization equipment, weatherproofing, lighting, grounding and foundation. Guyed towers may require more frequent maintenance than self-supporting towers, and the guy cables should be inspected for proper tension and to detect corrosion. Proper tension ensures that the tower is supported correctly and that there is minimal deflection of antennas caused by twisting of the tower. Guy cables are either stranded or braided and galvanized to prevent corrosion. Chipped or cracked bonding should be repaired. Self-supporting towers with tubular members require closer inspection for corrosion than those with angle members, where all surfaces are exposed. Some tubular members have "weep holes" drilled at the bottom to permit moisture drainage, and inspection should ensure that these holes have not been plugged.

Guyed towers

Guyed towers suit a wide range of loading conditions from light applications (including light-duty microwave, cellular and land mobile radio) to extremely heavy loading (such as heavy cellular, medium-to-heavy microwave, broadcast, and medium-to-heavy cable television and low-power television). (See Photo 1 above left.) The weight of ice and the stress of

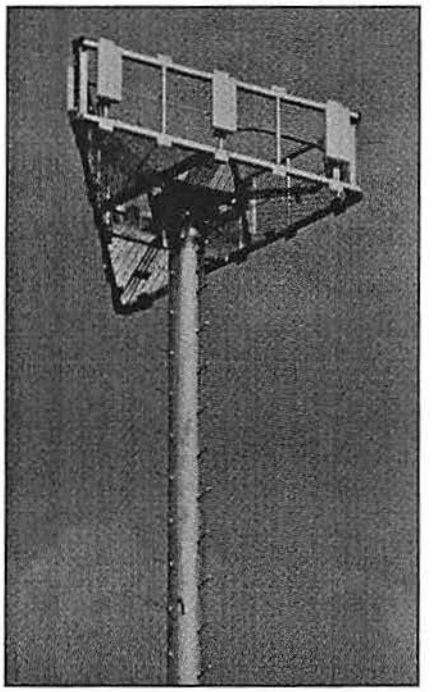


Photo 3. This step-tapered monopole tower exposes less area to the wind, which results in reduced loads. The transmission line is protected because it runs inside the pole.

high winds also can contribute to heavy loading on a tower.

A guyed tower may be constructed of formed, high-strength, steel-plate, angle leg and bracing members that bolt together, or as all-welded, solid, round members that arrive in 20-foot, prefabricated sections. These sections bolt together quickly to reduce installation time and costs.

The "face width" is the measurement of each side of the tower structure. For example, if a tower is model M36, the width of each face is 36 inches. The larger the face width, the more structural capacity that is available for installing antennas, ice shields, and radomes.

Self-supporting towers

Self-supporting towers come in a range of custom-designed shapes with triangular or square footprints as well as a single pole (monopole). Towers with triangular footprints are generally preferred over those with square footprints because they are lighter and more economical to erect, and they have lower overall foundation costs. These towers fit lightweight applications such as cellular and mobile two-way radio, and they are practical for use where space is limited or costly. For heavy microwave applications, towers with triangular footprints towers can be designed to handle many antennas along with other loads such as ice shields, platforms, large antenna feed lines, wind and ice. (See Photo 2 on page 46.)

The single-pole self-supporting tower, usually referred to as a monopole, can be a tubular section design or a formed, 12-sided, tapered pole with an equal taper along its length. (See Photo 3 at the left.) Monopoles generally range from 75 to 150 feet high. Above 150 feet, the pole may be too large to be cost effective and may not provide the stability to keep some antennas aligned correctly under adverse conditions. Compared with other tower types, monopoles require far less land. They often are more acceptable to zoning boards because they are better-looking and less obtrusive in the skyline. They are typically used for cellular applications. Generally, monopoles are more expensive than latticed self-supporting towers.

Quoting a tower

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and in the future), the next step is to contact manufacturers for quotations. The tower manufacturer needs several key items of information to provide you with useful quotations on a tower that will meet both your requirements and any restrictions, such as zoning codes or land availability. The most vital information you should supply is:

1. **Design load.** Use EIA/TIA specifications, the telecommunications industry standard design criteria, and note the revision level. These govern the tower unless local codes supersede them.

2. **Wind speed.** Sometimes referred to as wind load, this is the force the wind has on the tower and antennas. These measurements are predetermined for all U.S. counties in the EIA specifications and are stated in pounds per square foot (psf) or miles per hour (mph). For any given site, towers can be designed for heavier wind speeds than specified.

3. **Ice load.** Also known as radial ice, this is the amount of ice in inches formed around each tower member. Minimums are precalculated for various parts of the country, but the design can be altered for heavier icing conditions.

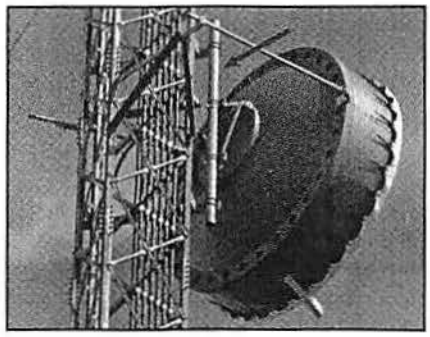

Photo 4. This antenna pipe mount (arrow) supports a 10-foot, high-performance, shielded microwave antenna on a 46- or 54-inch face width guyed tower.

4. **Soil report.** This report details the soil conditions present at the site and helps to determine what type of foundation is required. The engineering staff can use the EIA Normal Soil industry standard specification to quote on an installation, but this is strictly for a "budgetary quote" for a tower and foundation. When it comes time to design the foundation for a specific tower, an actual soil report must be provided. Foundation design is based on tower reactions and soil conditions. Independent geotechnical engineering companies usually are hired by the buyer to prepare the soil report. For convenience, most tower manufacturers can subcontract this service for an additional fee.

5. **Other design specifications.** Additional specifications might include Uniform Building Code (UBC), Building Officials and Code Administrators (BOCA), Southern Standard Building Code (SSBC), or specific government agency requirements in the area where the tower will be built. These specifications are in addition to the limitations stated in permits issued by the Federal Aviation Administration (FAA) or Federal Communications Commission (FCC). All codes will affect the factors used to determine loading requirements.

6. **Antenna loading.** Antenna loading covers anything added to the tower, initially or in the future, that will be exposed to the wind. At this step, it is important to think about what plans you have for the tower:

a. *Quantity.* Number of antennas, both initial and future installations.

b. *Models.* List of part and model

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numbers for antennas to be used. These numbers tell the tower design engineer the exact size, weight and frequency of the antennas to determine how rigid the tower must be.

c. *Size*. Diameter of each microwave antenna.

d. *Type*. Each type of antenna, high-performance, grid, cellular or broadcast, affects windloading differently.

e. *Elevation*. Placement on the tower of each antenna (feet above ground level).

f. *Azimuth*. Direction the antenna faces, usually in degrees. This aspect determines the placement of each antenna on the tower.

g. *Radomes*. Identification of the antennas that will have radomes (covers that protect antennas from dirt, wind, and ice).

h. *Coaxial cable and waveguide*. The kind of cable (foam or air dielectric) and/or elliptical waveguide and the sizes that will be used.

i. *Operating frequency*. Used to determine allowable twist and sway, especially on self-supporting towers.

7. **Other accessories.** Everything placed on the tower must be specified because added weight and windload will

Photo 5. A triangular platform (red arrow) and retractable side arms (white arrows) atop a pyramidal tower designed for light-to-medium loading.

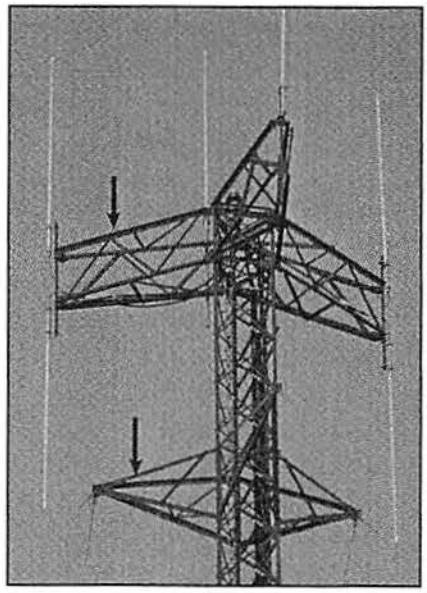

Photo 6. Cellular star mount frames (black arrow) support directional, omnidirectional, and sectored antennas. Torque stabilizers (purple arrow) add tower twist protection to maintain critical antenna alignment.

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affect the type and construction of the tower:

a. *Antenna mounts.*
b. *Platforms.*
c. *Side arms.*
d. *Climbing devices* (ladders, step bolts, safety climb devices).
e. *Paint* (shop or field).
f. *Lighting* (red light, strobe, or dual).
g. *Grounding* (EIA or special).
h. *Ice shields.*
i. *Waveguide bridge.*

Once all the tower information is compiled and submitted, engineers can develop specifications for both the tower and foundation and can help you with exhibits for the zoning processes. Exhibits might include one or more of the following:

- foundation design.
- site layout drawing.
- permit tower drawing packages.
- calculations and drawings for the foundation and tower structure bearing the seal of a registered professional engineer.

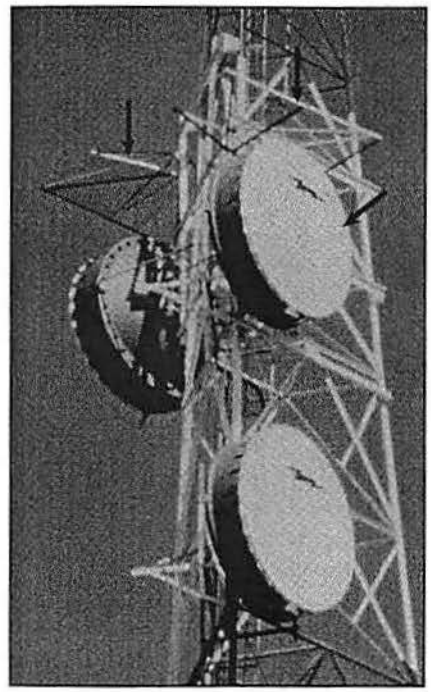

Photo 7. Ice shields (black arrows) are used to protect parabolic antennas, such as this one atop a heavily loaded microwave tower. The polymer-coated fiberglass radomes (purple arrow) also shed ice and snow to maintain the integrity of the antenna feed.

Tower site construction involves many steps: building an access road; bringing in electric and phone lines; erecting a fence and installing other security measures; providing and installing the equipment shelter; erecting the tower and installing transmissions lines and antennas; and testing alignment of all lines and antennas. Some tower manufacturers will provide a turnkey program that packages all of these services, or you may contract with different suppliers for the various services.

Putting up a tower is not difficult when you know what information you need and accumulate it up front. Start by deciding what you want to accomplish with the tower both at the initial purchase and in the future. Select a tower manufacturer that stands behind its design, materials and service. Give that company all the information you can. Select a reputable tower installer to protect the investment you make in the equipment. Finally, inspect and maintain your tower regularly.

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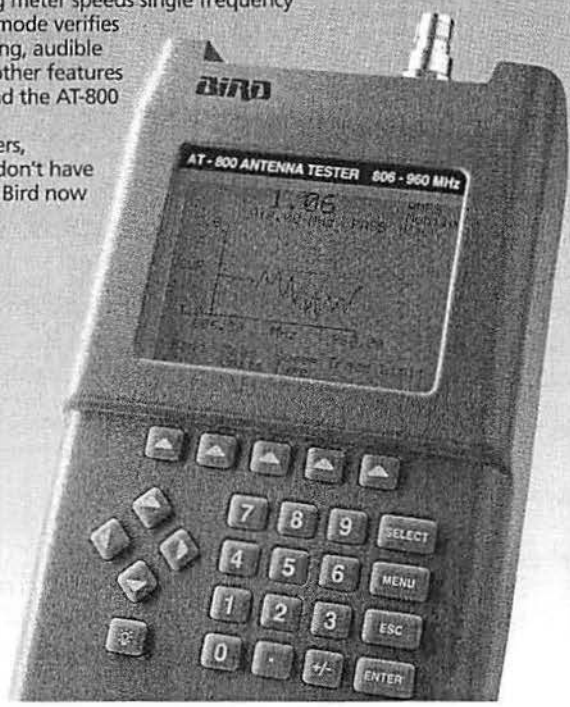

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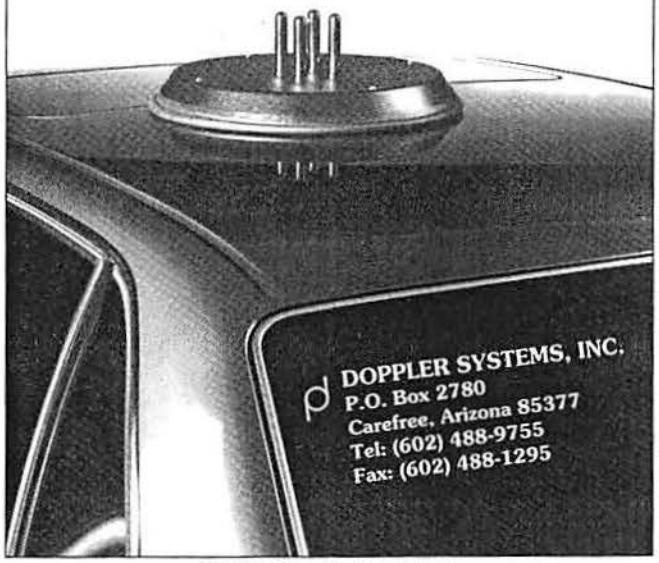

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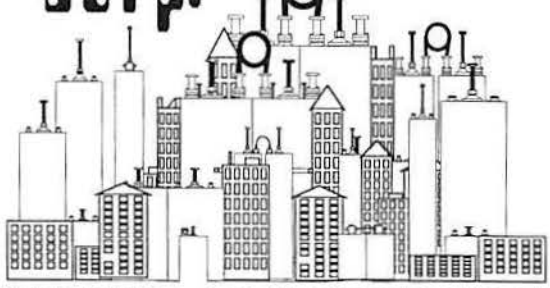

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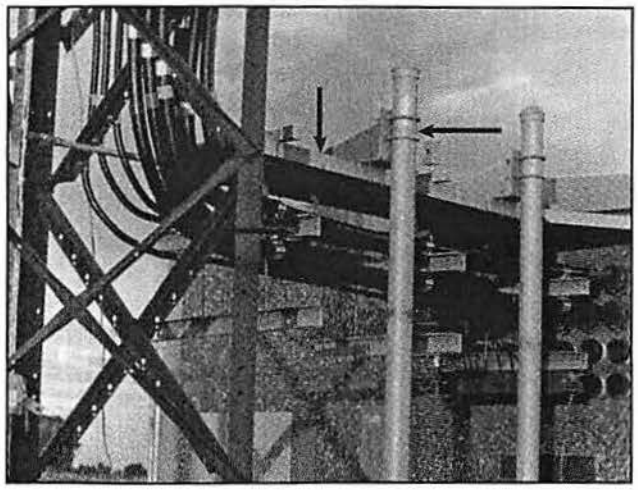


Photo 8. A waveguide bridge (black arrow) protects from four to 24 cable runs and is installed with a supporting system (purple arrows) of pipes and cable hangers.

GLOSSARY OF TOWER TERMS

The accompanying glossary identifies the terms most frequently used in purchasing a tower. Become familiar with them, and know which ones in particular affect the decision-making process for the tower you want to erect.

Antenna pipe mount A pipe used to mount an antenna to a tower. (See Photo 4 on page 50.) This mount should be ordered with the tower when microwave antennas are part of the initial installation.

Cable safety climb A safety belt and cable worn by workers when they climb the tower. A locking device, which travels along the safety cable, is attached to the safety belt to prevent the climber from falling.

Cellular antenna platform A square and/or triangular platform that provides a safe working environment for cellular antenna installation and adjustment. (See Photo 5 on page 52.) It also provides mounting support for antennas.

Cellular star mount A triplex frame that can support as many as 12 whip antennas with the other cellular antennas that are separated by 20 or 30 feet. (Photo 6 on page 52.)

Climbing ladder A ladder mounted either on the outside of a tower or internally such that two tower faces form a safety cage.

EIA Electronic Industries Association.

FAA dual red light/strobe system A kit of components needed to comply with FAA and FCC regulations. It consists of a combination of red light beacons and

sidelights that flash after dusk and white strobes that flash during daylight hours. The flashing strobe could be a nuisance to the surrounding populated areas at night, so less objectionable red beacons are used. No paint is required for the tower.

FAA strobe light system A flashing white beacon at the top. No paint is required for the tower.

Grounding system A series of copper wires and buried rods used to ground the tower, shelter, and transmission line. It is one of the most important deterrents to lightning damage. One lightning strike could bring the entire system down, resulting in a loss of revenue.

Ice shield A canopy installed directly above an antenna to protect it from damage caused by falling ice and other windblown debris. (See Photo 7 on page 54.)

Light controller A solid-state electronic device equipped with a photoelectric cell that turns tower lights on and off. Alarms indicate beacon, sidelight or power failures.

Paint A paint that adheres to galvanized steel. Painting is typically done in the field; however, factory applied paint is also available. The FAA requires that towers 200 feet and taller be painted and/or lighted. Towers shorter than 200 feet may require painting and/or lighting if they are near an airport. Painting consists of seven equally

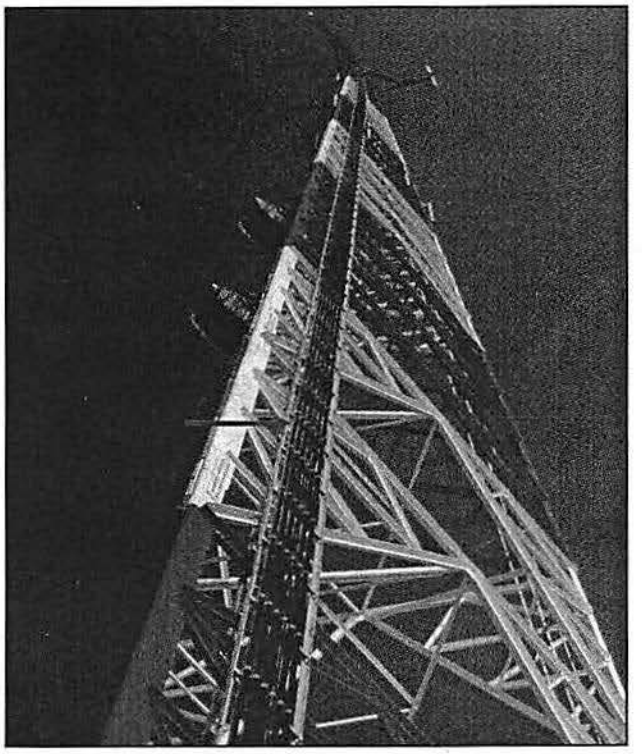
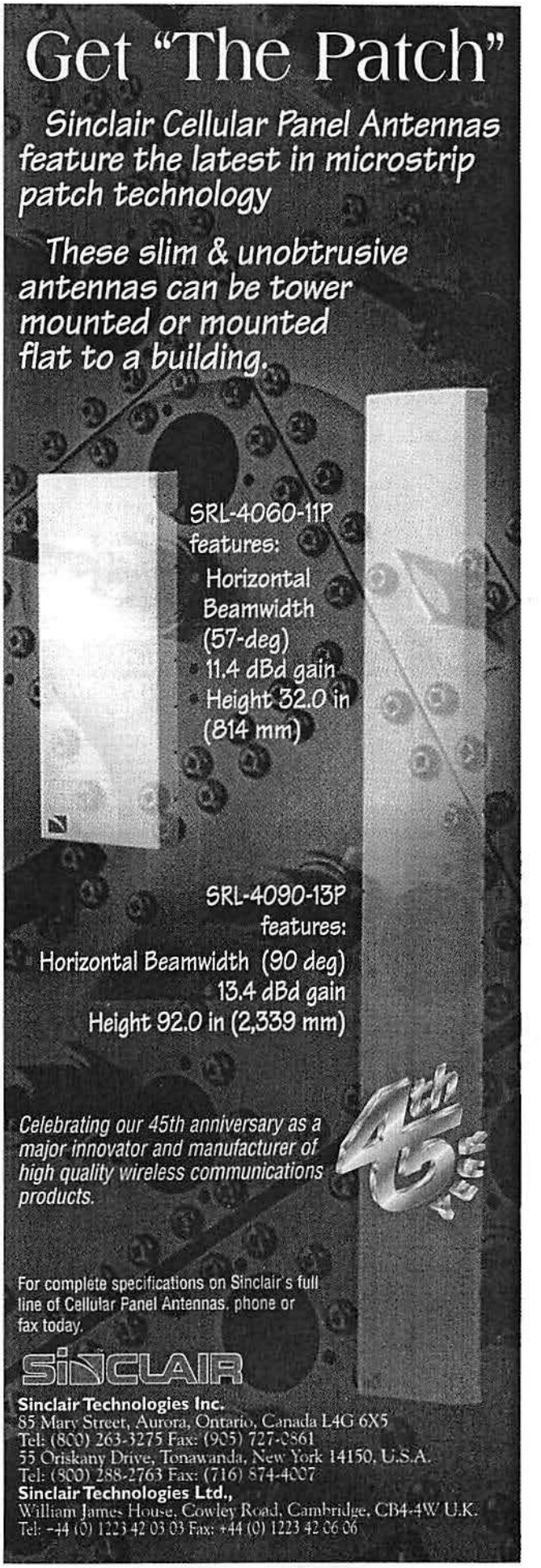


Photo 9. A waveguide ladder (arrow) supports six runs of waveguide on an SST. The waveguide ladder on a guyed tower is shown in Photo 1.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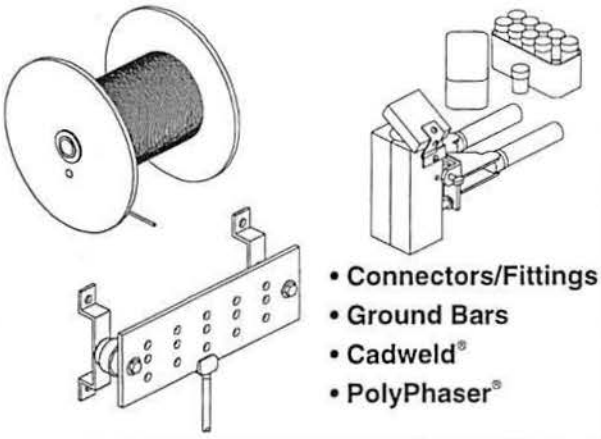

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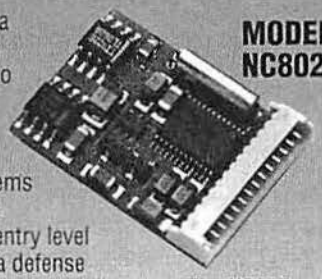

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spaced bands, three of aviation white and four of aviation orange.

Radomes A cover installed over the antenna to protect the antenna and feed from accumulation of ice, snow and dirt and to help reduce wind loading. There are two basic types. Flexible planar radomes are stretched across the front of shielded antennas. They are made of either hypalon-coated nylon (lasts 5 to 15 years) or a polymer-coated fiberglass fabric (lasts 10 to 30 years). (See Photo 7 on page 54.) The radome flexes slightly in the wind and thus sheds ice and snow and protects the antenna feed. The second type is a molded or formed radome, usually made of fiberglass or plastic. These radomes are parabolic (dishlike) or cone-shaped and are attached to the rim of the reflector. They also provide protection to the feed even in severe environmental conditions.

Side arms Extensions from a tower that increase the clear distance between the antenna and the tower to minimize the interference created by the tower structure (See Photo 5 on page 52.)

TIA Telecommunications Industries Association

Torque stabilizers An assembly of extended arms used on a guyed tower to help prevent twist. (See Photo 6 on page 52.) They are generally attached above or below a microwave antenna.

Tower analysis A computer-generated report used to design new towers, to determine the modifications necessary to an existing tower before the addition of antennas, transmission lines, or accessories, or to change the height. Without a tower analysis, nothing should be added to a tower structure that was not specified in the original design.

Waveguide bridge A cover installed between the tower and shelter to protect the transmission lines from falling ice or other debris. (See Photo 8 on page 56.)

Waveguide bridge/support system A system that supports the transmission line between the tower and the shelter entry ports (openings in the building where the cable enters). (See Photo 8 on page 56.)

Waveguide ladder A support system designed to attach the transmission line to the tower. In a guyed tower, this support system is usually built-in. It consists of diagonal braces (with prepunched holes to accommodate hangers), which replace support diagonals at certain intervals. Waveguide ladders are also available for self-supporting towers. (See Photo 9 on page 57.) These supports bolt directly to the tower bracing for mounting transmission line without angle adapters or special brackets.